Behavior of Corroded Pipelines Under Cyclic Pressure Project 153K

3rd QUARTERLY PUBLIC REPORT

Period: September through December 2005

Consolidated Research and Development Program to Assess the Structural Significance of Pipeline Corrosion

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Background

Metal loss due to localized corrosion and pitting of pipelines can significantly increase the risk of rupture. Therefore, it is vitally important to accurately determine the residual strength of corroded pipelines so that proper remedial actions may be taken to avoid catastrophic events. Although historical methods and practices for inspection and integrity assessment have led to an overall safe and reliable pipeline infrastructure with a low frequency of failures, public expectations concerning pipeline safety are growing, and industry is committed to pursuing further improvements. Consequently, new US regulations and sophisticated inspection technologies have burdened many operators with large quantities of data that are often difficult to interpret and apply within the framework of existing assessment guidelines. Clearly, the industry needs a technically sound, comprehensive and integrated approach to assess and mitigate the effects of localized corrosion in gas and oil pipelines, and to assure appropriate pressure-containment safety margins.

Several methods have been developed for assessment of corrosion defects, such as ASME B31G, RSTRENG and LPC. These methods were developed using an early fracture mechanics relationship for toughness-independent failure of pressurized pipes and were empirically calibrated against a database of full-scale burst tests for thin wall pipes. Some work has already been done to address the limitations of existing assessment methods available to the industry. The objective of this project is to establish the potential for fatigue failure from corrosion.

Summary of Progress this Quarter

A full scale fatigue test program was developed on the basis of the literature review and finite element (FE) studies undertaken. Four defects have been machined into the pipe wall to represent corrosion defects. Testing is scheduled to commence early in 2006. The defects have been shot blasted and the pipe has been left outside to permit the surface of the defects to corrode to ensure that the number of fatigue cycles to crack initiation will be truly representative of a corrosion defect and not unduly influenced by surface profile.

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Results

A literature review has been completed. It has been concluded that there is little information (either analytical or experimental) to determine SCFs in pipelines with corrosion defects. No general formulas can be used to determine SCFs and the consensus of opinion is that SCFs must be generated on a case by case basis using finite element analysis, validated by limited full scale testing.

Finite Element analyses have been completed. The models considered different pipe sizes and corrosion damage (variation in depth and axial/circumferential length). The results from the studies undertaken show:

- For a given axial length, the SCF decreases as the circumferential width increases. There is no further reduction in SCF for circumferential widths greater than 12.5% of the pipe circumference for a *D/t* of 40. This limit was found to decrease (7%) for a *D/t* of 72. It should be noted, however, that the analyses were limited for *D/t*=40.

- For a given circumferential width, the SCF increases as the axial length increases. A limiting SCF is achieved but the corresponding axial length is dependent on defect depth (i.e., the greater the defect depth the longer the required axial defect length to achieve a limiting SCF).

- For a given axial and circumferential defect length, the SCF decreases as *D/t* decreases.

- The smaller the blend radius (*r*) between the pipe and metal loss defect (in the pipe circumferential plane) the higher the SCF. The studies considered *r/t* of 1 and 0.5 only.

Future Activities

Work over the next quarter will focus on full scale fatigue test and using the results from the FE studies to predict the fatigue life of the simulated corrosion defects.

Additionally, the project team will be participating in an OPS sponsored Peer Review of the project on February 7, 2006.

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